Fire History Analysis from Fire Scars Collected at Iceberg Point and Point Colville on Lopez Island, Washington State

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Abstract

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Historical grasslands, located on Lopez Island of Washington State have undergone transformation to coniferous trees, shrubs, and non-native grasses and forbs. Analyses of fire scars from two parcels of land located on Lopez Island and administered by the Bureau of Land Management have revealed a rather frequent fire pattern during the past 340 years. Weibull median fire-free intervals of 11.4 and 14.8 years were calculated based on a total of 23 fire-scarred samples. The last significant fire occurred in 1916 interrupting the recurring fire pattern by which these grasslands have at least partially evolved. If restoration of grasslands to historical conditions is a management goal on Lopez Island, then historical fire-disturbance patterns should be given ample consideration.

Introduction

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Restoring and preserving natural environments beneficial to scenic, botanical or wildlife values are becoming particularly crucial (Nature Conservancy 1975) since many surviving historical landscapes are in a state of decline. Public lands have assumed increased significance, as land managers attempt to maintain unique landscapes otherwise limited or unavailable (Cosand 1985). On the San Juan Islands of Washington State (Figure 1), resource specialists have observed and documented the transformation of historical grasslands toward shrub and forested landscapes (Agee and Dunwiddie 1984, Agee 1987, Peterson and Hammer 2001).
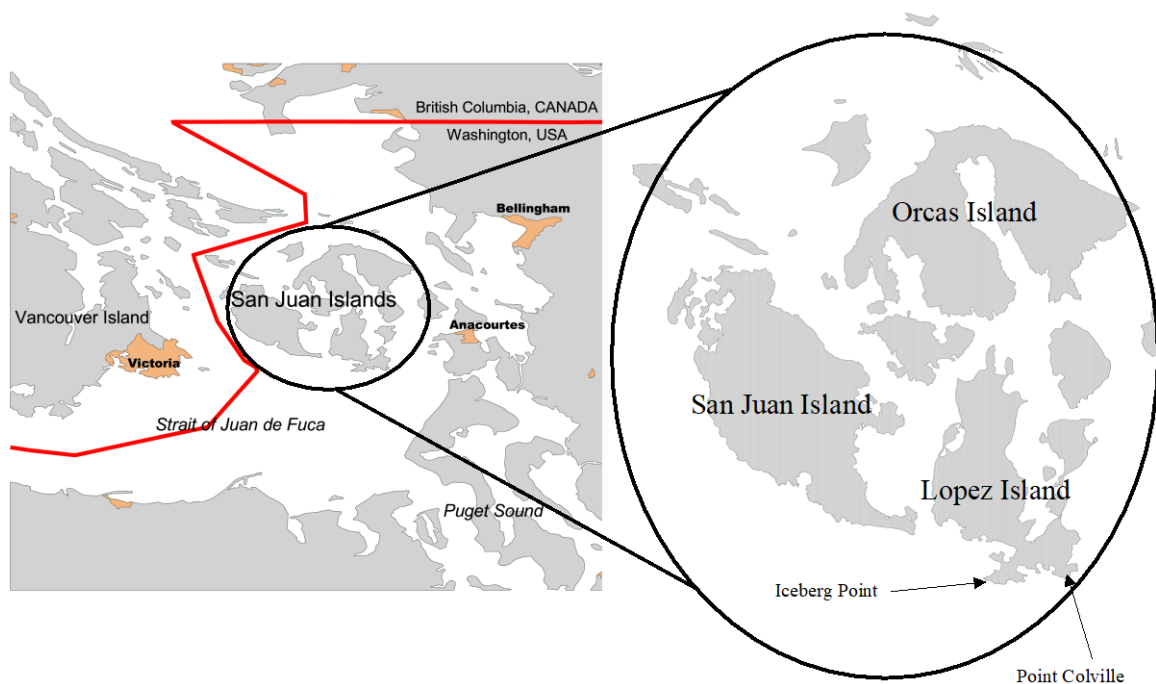

Figure 1. Location of the Iceberg Point and Point Colville study sites within the San Juan Archipelago of northwestern Washington State.

There is a rising interest in restoring the historical vegetative structures to these discrete plant communities (Nature Conservancy 1975). Restoration efforts necessitate that land managers understand the processes that influence the development of natural landscapes (Schellhaas et al. 2002a & 2002b). Natural or human disturbances and biophysical characteristics are major factors in shaping the arrangement and structure of natural environments. The rate of recurrence and timing of historical disturbances are essential reference points for any attempt to re-establish and maintain historical biological conditions (Everett et al. 2000).

Historically, fire has been an important factor leading to the development of landscapes on the San Juan Islands. Native Americans appear to have been responsible for most historical ignitions (Agee and Dunwiddie, 1984, Peterson and Hammer, 2001). Escaped cooking fires, driving animals for hunting, and preparation of grasslands to facilitate edible-root growth and animal forage are some reasons for past, aboriginal ignitions (Agee and Dunwiddie 1984, Agee 1987). Additionally, there are some documented reports of burning by early Euro-American settlers (Cosand 1985), presumably associated with land clearing operations

Periodic fires in the Puget Trough were instrumental in maintaining historical native grassland habitat by limiting successional encroachment of trees and shrubs (Sheehan and Sprague 1984, Kruckeberg 1991, Agee 1993). Portions of these grasslands may be potentially suited for restoration to historical vegetative structures. Therefore, the primary objective of this study is to define the contemporary and historical fire disturbances that have contributed to the arrangement and structure of current and past

vegetation within the Iceberg point and Point Colville areas on Lopez Island of
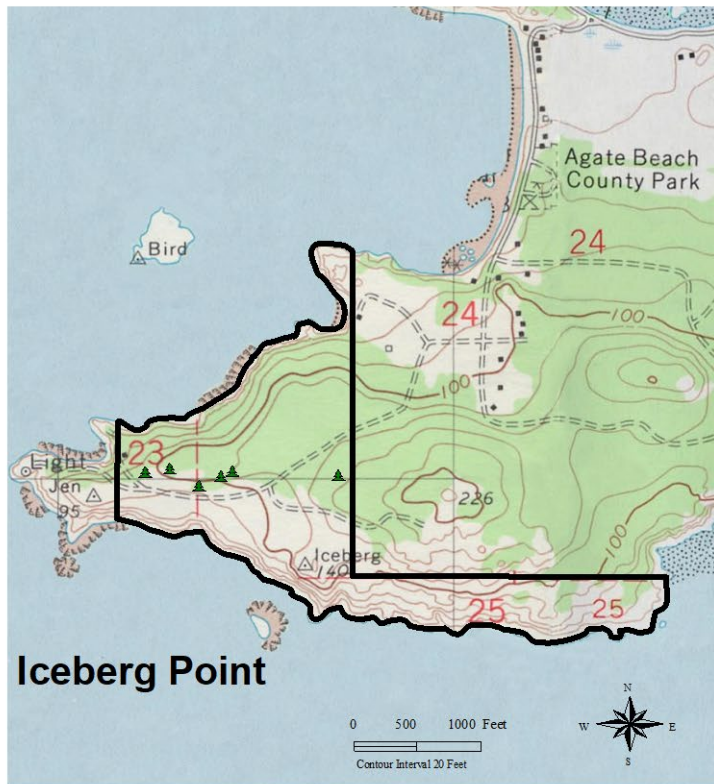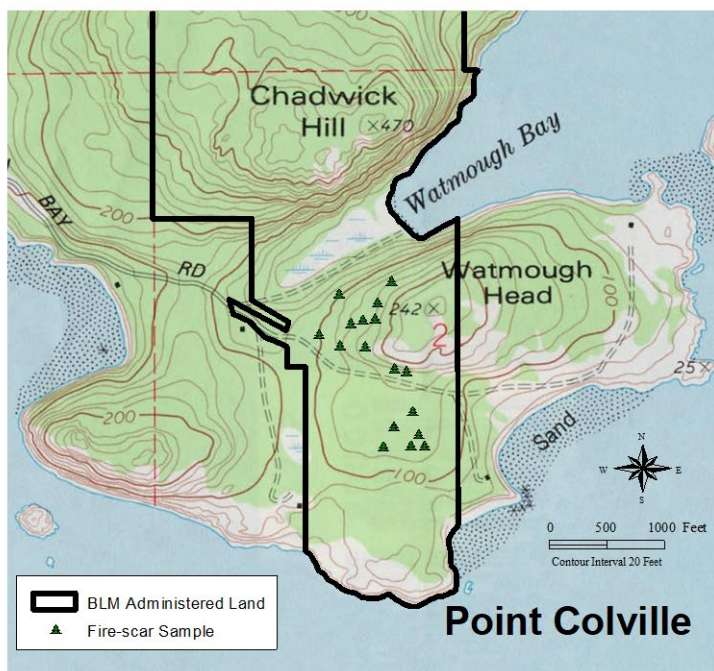
Washington State (Figure 2).

Figure 2. Location of fire-scar samples within the Iceberg Point and Point Colville Areas of Critical Environmental Concern (ACEC).

Study Area

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The Iceberg Point and Point Colville areas are located along the southern shores of Lopez Island. Lopez is one of three main islands among the San Juan archipelago group, located in Puget Sound, east of Vancouver Island (Figure 1).

These parcels of federal land are designated as "Areas of Critical Environmental Concern" (ACEC) (Figure 2) and are administered by the United States Department of Interior's Bureau of Land Management (BLM). The Iceberg Point segment encompasses approximately 75 acres, about half of which is forested. The Point Colville area contains just over 400 acres and includes approximately 120 acres of forested terrain. Current vegetation on nearby San Juan Island is represented in part by invading species that have proliferated during the most recent 100-150 years, when Euro-American settlement began (Agee 1984). Grazing may be responsible for the invasion of some non-native vegetation that is beginning to occupy many of the historical grasslands on Lopez Island (Nature Conservancy 1975). Coniferous tree invasion within the grasslands is apparent as well.

The San Juan Islands lie within the rain shadow of the Olympic Mountains and receive approximately half of the annual precipitation of most nearby Puget Sound locations (Stevens 1975, Fonda and Bernardi 1976). These islands maintain some of the driest sites encountered in western Washington and have soils primarily composed of glacial till that are naturally well drained (Franklin and Dyrness 1973). Soil depths of both ACECs are generally shallow and grade to rock outcrops near the shores. The combination of modest precipitation and thin soils give rise to plant communities not unlike many dry forests types found along the eastern slopes of the Washington Cascade

Mountains. South to west aspects are most typically exposed to dry summer winds (Agee 1987) and consequently are where most natural grasslands are found in the San Juan Islands group.

Invading conifers into the grasslands of Lopez Island appear to have developed similar characteristics to the krummholz effect often observed in arctic or alpine ecosystems (Arno and Hammerly 1984). As trees are subjected to severe conditions they become stunted and shrub-like. However, in the protection of initial pioneers a more favorable micro-site is provided for subsequent individuals. Eventually, a copse of trees increasing in height to the leeward is formed. Agee (1984) describes a similar scenario on nearby Yellow Island as a "positive feedback loop" but elaborates that when limits of wind protection and moisture depletion are reached, further tree establishment is curtailed. In the case of the Iceberg Point and Point Colville ACECs, the limiting factor for establishment and growth is summer soil-drying and south to westerly winds (Agee 1987, Fonda and Bernardi 1976).

Forests at Iceberg Point and Point Colville are virtually untouched. Only relatively small areas within the Point Colville area south and east of Watmough Bay and on Chadwick Hill (Figure 2) have experienced any appreciable logging activities. Piling poles were harvested in the vicinity (Cosand 1985) but it is not known whether this activity took place within the study areas. Except for a small maintenance road through the Iceberg Point parcel and a few roads within the Point Colville area, the stands are essentially intact. Douglas-fir (*Pseudotsuga menziesii*) is the dominant tree species represented at all locations. Western red cedar (*Thuja plicata*) and Sitka spruce (*Picea sitchensis*) are also common in addition to lesser amounts of shore pine (*Pinus contorta*

var. *contorta*). Grand fir (*Abies grandis*) is found within the understory layers as well as an intermediate component of the overstory. Western hemlock (*Tsuga heterophylla*) and pacific madrone (*Arbutus menziesii*) are sparsely represented although madrone is common on Chadwick Hill.

Methods

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Some fire history investigations have subdivided study areas into unique biophysical units to improve fire history description and minimize statistical variability (Schellhaas et al. 2002a & 2002b). Segments within the Iceberg Point area were not sufficiently distinguishable to dictate further subdivision. However, the Point Colville area did have two distinct biophysical conditions that required separation. The Chadwick Hill area near Point Colville showed enough topographical distinction (Figure 2) and difference in vegetation cover to necessitate separation from the remainder of the study area.

In the absence of fire scars, fire history researchers occasionally rely on tree regeneration data to establish demographic evidence of disturbance dates (Heinselman 1973). This procedure requires a series of random or systematic plots to be installed and numerous tree cores to be collected. It was established through field reconnaissance that fire scars existed in sufficient quantities to eliminate any need for age class determination in all but the Chadwick Hill area. However, the Chadwick Hill portion was an area of lesser priority and as resources were somewhat limited for age cohort examinations, it was excluded from the analysis.

Field methods

Figure 3. This live 30-inch Douglas-fir tree contained the most complete fire record of any sample in our study, recording fires dating from 1765 to 1863 (Mean fire-free interval = 12.2 years). The "bore cut" method of extraction allowed for minimal damage to the tree while enabling a solid wedge (photo inset) to be removed for precise dating of fire events.

Data for this investigation was collected in May of 2003 within the ACECs previously described. All areas were intensively searched for evidence of past fire from fire-scarred trees, snags or logs. On living trees and snags, wedges containing the fire scars were removed using the methods outlined by Arno and Sneck (1977). The "bore cut" method of scar extraction they describe was utilized to minimize damage to live trees and large snags (Figure 3). Samples from logs were sectioned to ensure that the maximum number of fire-scar events was acquired. Locations of fire-scarred samples were geo-referenced and entered into a geographical information system (GIS) database for subsequent mapping of fire locations. A number of tree cores were collected to verify the age of the stands and to support the development of a tree-ring chronology.

Figure 4. This 40-inch Douglas-fir snag shows the typical scarring that results from fire: triangular in shape, extending to the tree base, and having charcoal on exposed wood (Agee 1993).

Samples were selected from scarred trees having charred wood and typical ground-level, triangular shapes (Figure 4) (Agee 1993). Care was taken not to mistake traditional fire scars with western red cedar bole-scars created by indigenous inhabitants. These natives removed long strips of bark originating from a single notch placed on the tree bole or stripped the bark between two horizontal axe cut regions, forming a rectangular shaped scar (Figure 5). The bark material had many uses including clothing, rope, and basket construction (Johnson-Gottesfeld 1992). Consequently, for additional corroboration and to alleviate any ambiguity, we validated all western red cedar-scar fire-dates with more reliable Douglas-fir samples.

We selected a total of 23 fire-scar samples to document the fire-disturbance history at the Iceberg Point and Point Colville study sites (Figure 2 & Figure 8). All 6 samples

Figure 5. Native inhabitants removed the bark of western red cedar for use in their daily lives often causing rectangular shaped scars that can be seen today. The bark on this tree was removed after the last fire since the exposed wood contains no charring. Had charcoal been present, some may confuse the initial scar with a fire but to the trained eye, the rectangular shape is one clear indication to its origin.

collected at Iceberg Point and 10 of the 17 Point Colville samples were from Douglas-fir trees. The remaining 7 samples selected at the Point Colville site were taken from western red cedar.

Laboratory preparation and analysis

Tree-ring cores were glued onto grooved boards and allowed to dry. The cores were then sanded to a fine finish to improve clarity. Each ring was measured on a Velmex sliding-stage micrometer with an Acu-Rite encoder using the Measure J2X software (2001). The tree-ring measurements were validated for dating accuracy with the COFECHA software program (Holmes et al.
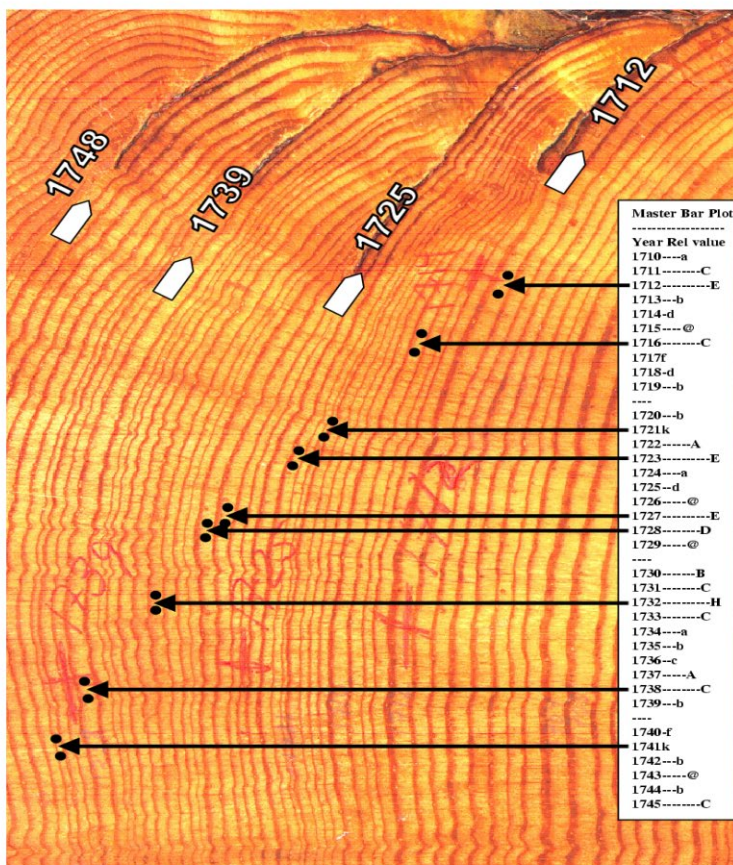
Figure 6. Wide and narrow rings on this fire-scar sample correspond to the "Master Bar Plot" in this example from the Okanogan and Wenatchee National Forests in eastern Washington (Schellhaas et al. 2002a). The long-wide (upper-cased letters) and short-narrow (lower-cased letters) bars created in COFECHA signify rings wider and narrower, respectively, than average. The fire scars (white arrows) were precisely determined based on these distinctive ring patterns. We used the same method to date all fire scars at Iceberg Point and Point Colville.

1986) that also produced a graphical master chronology of tree-ring widths representing effects of annual precipitation (Figure 6). These procedures generated a chronology, analogous to the skeleton plot described by Stokes and Smiley (1968), and included the period of time from the years 1633 to 2003.

The master tree-ring chronology was used as an aid to cross-date fire-scar samples. Cross-dating is the process of matching variations in tree-ring widths or other ring characteristics among several samples, allowing the precise year of each ring to be established (Kaennel and Schweingruber 1995, Stokes and Smiley 1968). Signature or marker years (Yamaguchi 1991) and recognizable patterns of years were used to assign the correct calendar year to each scar (Madany et al. 1982, Dietrich and Swetnam 1984, Brown and Swetnam 1994, Grissino-Mayer 1995a).

Each fire scar cross-section was sanded with a progression of sandpapers, concluding with either 320 or 400 grit to permit scrutiny of extremely small growth rings. Many of the samples collected were substantially decomposed and required careful reassembly before they could be sanded and their fire scars dated. Fire-scar dates were then established by utilizing the list of marker years or by visually comparing ring patterns with those in the master chronology, thereby mitigating the adverse effects of some partially decayed, dead or damaged samples. Once each fire scar was assigned a date, these data were analyzed using the FHX2 software package (Grissino-Mayer 1995b).

The occurrence of fire over time is generally described as fire frequency, which is an important concept when comparing fire-history information between various investigations. A compilation of fires determined across a designated area is referred to

as "area frequency". An additional method of displaying fire history information is point frequency. "Point frequency" is the mean fire interval at a single point (a fire-scarred tree) on the landscape, but can be expanded to include samples from several proximate trees (Agee 1993). Unless specified, all references to fire frequency will be considered area frequencies.

The arithmetic mean of all fire-free intervals determined within a designated area or point during a selected period of time is referred to as the mean fire-free interval (MFFI). Although fire-interval distributions have traditionally been described utilizing the MFFI, a better statistic to describe fire regimes may be the Weibull median fire-free interval (WMFFI). Grissino-Mayer (1995a) suggests that WMFFI is a more accurate metric for characterizing fire regimes when fire frequency distributions are skewed (the distribution curve is not normal or bell-shaped). In addition to the WMFFI and the MFFI, the Weibull Exceedance Probability Range (WEPR) was calculated for each study site to document any statistically-significant short or long intervals that may be present (Grissino-Mayer 1995b). Grissino-Mayer recommends the less stringent 0.125 statistical-level, rather than the usual 0.05-level when making ecological interpretations based on fire-history data. For this study, we have chosen to follow the terminology used in the FHX2 fire history analysis software developed by Grissino-Mayer (1995b).

In addition to direct fire-scar evidence, tree core and fire-scar samples exhibiting aberrant ring-patterns that correlated with established fire years were also utilized. Individual fire years are displayed through a set of fire occurrence maps (appendix) generated from geo-referenced locations of fire-scarred cross-sections (Agee et al. 1986).

Results

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Evidence of previous fires is easily observed across both study sites. There are numerous Douglas-fir and western red cedar present that exhibit visible fire-scars. Most relict Douglas-fir trees have charred bark (Figure 7) and additional charred debris is conspicuous on and in the duff layer throughout both locations. Furthermore, the absence of large woody debris in many portions of the designated ACECs is anecdotal evidence of an active fire history, implying fuel consumption by earlier fires.

Figure 7. Charcoal was conspicuous throughout the Iceberg Point and Point Colville study areas. The large Douglas-fir trees in this picture show the char that was present at Point Colville.

Composite Chronology
Iceberg Point
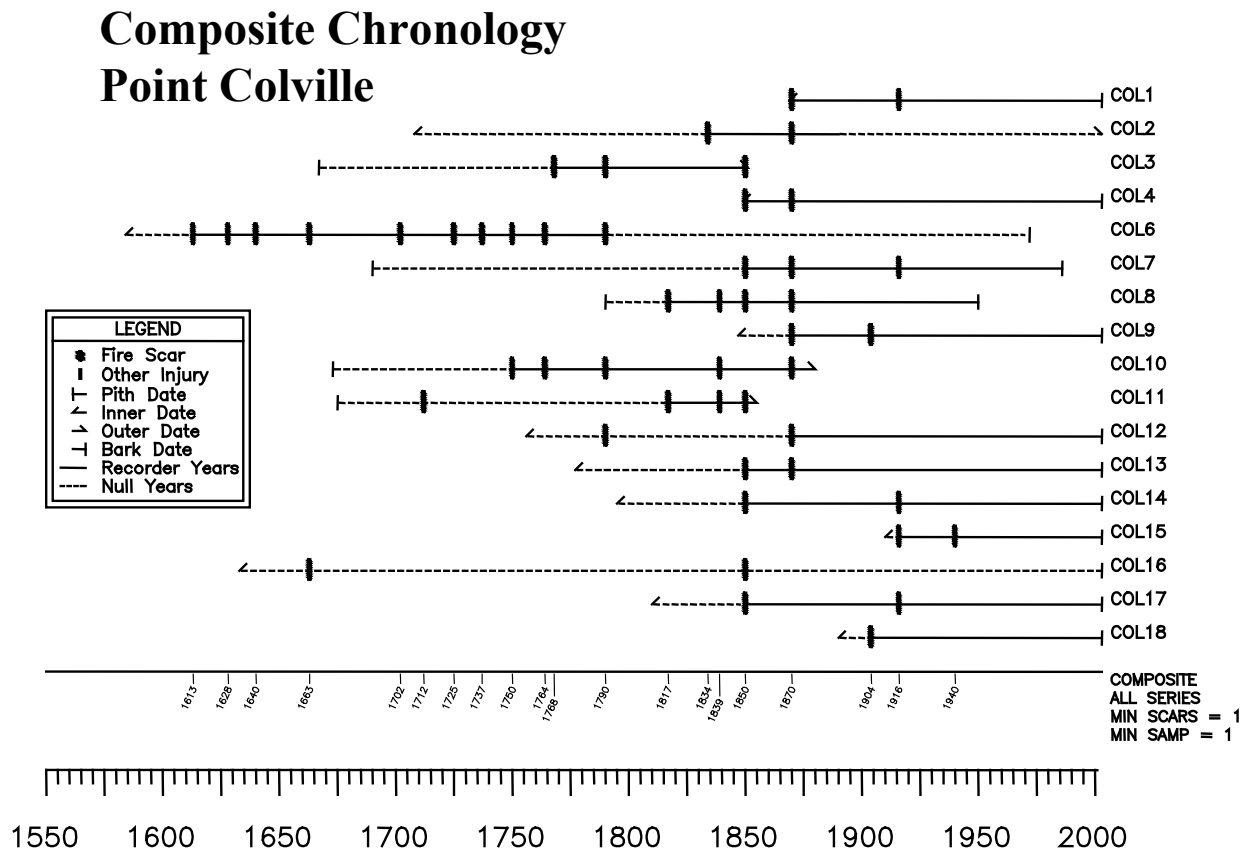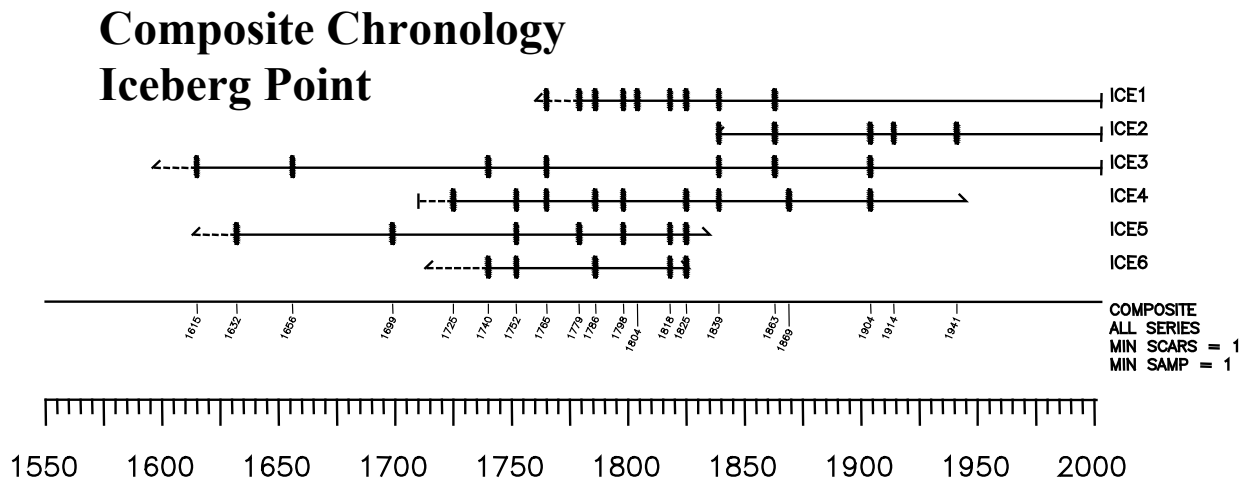
Figure 8. Composite chronologies of fire events from Iceberg Point and Point Colville were generated by FHX2 software (Grissino-Mayer 1995b) showing fire occurrence over time. Horizontal bars represent individual fire-scar samples with fire events indicated by short vertical bars.

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Time periods

Of all fire-scars and tree-cores collected, the oldest tree-ring date we were able to ascertain was 1584 (missing tree-center) and the oldest pith date was 1667. The earliest fire dates we were able to determine was 1615 at Iceberg Point and 1613 at Point Colville. Although we documented fires at these early dates, we were compelled to establish the beginning of the "period of reliability" (Touchan et al. 1996) at 1740 for Iceberg Point and 1663 for Point Colville. These dates represent the earliest point in time when at least two samples recorded the same fire event (Figure 8). We then determined the historical period as 1740 to 1869 at Iceberg Point and 1663 to 1870 at Point Colville.

Agee (1984) describes the settlement period on nearby San Juan Island as beginning in 1860. Similarly, we observed through our analysis of the fire record, a significant reduction in fire occurrence in 1869 at Iceberg Point and 1870 at Point Colville, apparently an impact of Euro-American settlement. The cessation of all but one fire occurred prior to 1920 at both locations. Consequently, we established the settlement period for Iceberg Point as 1869-1914 and 1870-1916 for Point Colville. The modern era for Iceberg Point and Point Colville begins in 1914 and 1916 respectively. This time period includes an inherently truncated interval (Everett el al. 2000) that ends with the date of the investigation. It should then be understood that the current fire-free interval and the reported mean interval (Table 1) are only temporary and will continue to increase annually until the next fire occurs.

Fire frequency

As previously described, the WMFFI may be a better metric for describing fire-return intervals but we also report the MFFI since the settlement and modern time periods do not provide an adequate sample size to compute the WMFFI statistic (Table 1). Including the MFFI also allows comparisons with other investigations since it is commonly used. Any further discussion of fire frequencies however, will utilize the WMFFI, unless specifically stated.

The historical WMFFI for the Iceberg Point area was established as 11.4 years. The range of all fire-free intervals within the historical time period is from 6 to 24 years. At Point Colville, the WMFFI is 14.8 years and the fire-free intervals ranged from 4 to 39 years. Fire occurrence is reduced during the settlement era most likely due to increased Euro-American settlement and reduced Native American influence. The WMFFI for the settlement era could not be computed for either the Iceberg Point or Point Colville ACECs, however the MFFI was calculated at 22.5 and 23.0 years respectively.

Two fires occurred in the modern era, one each at Iceberg Point and Point Colville that were only detected on one sample. Because these fires were only recorded on one sample, they were almost certainly spot fires of limited extent and probably suppressed. The 1941 fire at Iceberg Point was restricted to the far western edge of the sampled region. Similarly, a fire in 1940 was limited to a small area in the southeastern part of Point Colville. As reported earlier, the modern era MFFIs of 44.5 years for Iceberg Point and 43.5 years at Point Colville includes the abbreviated interval ending in year 2003.

Point frequencies at both locations showed longer mean intervals than the reported area frequency (Table 1), as is typically the case since larger areas are likely to experience more fires than smaller portions of the same area (Kilgore and Taylor 1979). The point frequency MFFI at Iceberg Point (from one sample [Figure 3]) is 12.2 years and is 20.7 years at Point Colville (from three adjacent samples). The slight discrepancy of point to area frequency (12.2 to 11.4 years) at Iceberg Point is indicative of common fires across that entire study area, whereas the greater difference (20.7 to 14.8 years) at Point Colville is attributable to exclusive fire events in 1712, 1768, and 1834 (Figure 8 and appendix) on the northwest-facing slope of Watmough Head.

Table 1. Fire frequency summary for Iceberg Point and Point Colville ACECs. At least three intervals are required for calculation of the WMFFI statistic so it is omitted for the Settlement and Modern Periods.

Location	Historical Period 1740-1869 † 1663-1870 ††				Settlement Period 1869-1914 † 1870-1916 ††		Modern Period 1914-present † 1916-present ††	
	WMFFI	WEPR	MFFI	Range	MFFI	Range	MFFI	Range
Iceberg Point †	11.4	5.9 – 17.8	11.73	6 – 24	22.5	10 – 35	44.5*	27 – 62*
Point Colville ††	14.8	6.1 – 26.6	15.9	4 – 39	23.0	12 – 34	43.5*	24 – 63*

* Representative of a truncated interval that will increase until the next fire occurs.
WMFFI – Weibull Median Fire-Free Interval
WEPR – Weibull Exceedance Probability Range
MFFI – Mean Fire-Free Interval
Range – minimum and maximum intervals

An additional statistic of use to land managers is the Weibull Exceedance Probability Range (WEPR). This statistic only lists fire intervals that lie within a certain level of statistical significance ($\alpha = 0.125$) rather than the absolute range. The WEPR

prioritizes the temporal distribution and allows the land manager to focus on the most significant portion of a range of intervals. The WEPR (based on area frequency) for Iceberg Point extends from 5.9 to 17.8 years and at the Point Colville site is from 6.1 to 26.6 years. This range gives land managers greater flexibility in timing management operations instead of scheduling according to a fixed mean.

Most scars typically occurred at or near the end of latewood annual-ring formation. However, some fires appear to have occurred during the early arboreal growing season when grass had cured somewhat but tree growth was still occurring. Earlywood tree-ring growth on the San Juan Islands is generally established from May to mid June (Morris 1990). We observed some fire scars in the initial stage of tree-ring development, indicating the early seasonal timing of the event.

Discussion
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Fire histories determined from actual fire-scar wedges are far more informative and accurate than from any other natural source (Barrett and Arno 1988). Ostensibly, this study is unique in that it utilizes actual fire-scar wedges (Figure 3) rather than merely relying on tree cores for validation of historic fires. As far we as we could determine, all previous studies regarding fire history within the San Juan Islands are based upon tree cores (Agee and Dunwiddie 1984, Peterson and Hammer 2001).

At Iceberg Point, many of the fire-scar samples were collected along the forest/grassland ecotone, where historical fire implications can be correlated to either adjacent closed-forests or grasslands. The grassland itself is incapable of recording

historical fire disturbances but that evidence is captured in the form of fire scars at the forest periphery. If one assumes that fires recorded within the closed forest type were initiated and spread from the grassland as would be expected given the prevailing wind pattern, then the recorded fires within the forest should be a valid depiction of the grassland fire regime.

The slightly longer WMFFI exhibited at Point Colville may be a result of the fire-scar sample locations. As stated, most Iceberg Point samples were located near the grasslands but the samples collected at Point Colville were farther from the shore and the current grassland (Figure 2). Some fire ignitions there may have diminished near the ecotone and expired within the closed forest zone. Regardless, the reported WMFFIs should be considered a conservative estimate of the grassland and forested landscapes.

Most fires detected within the study areas are apparently of low to moderate intensity. Numerous trees possess multiple fire scars, which can be indicative of lower fire intensity (Agee 1993, Schellhaas et al. 2002a & 2002b). Additionally, abundant fire-intolerant western red cedars sustaining multiple fires are present. Finally, most stands within these areas are multi-layered and multi-aged, which suggests regeneration that is not the result of a single catastrophic-disturbance event. A small area located at the extreme southwest portion of the Point Colville site is one of the only areas that has been recently stand replaced. This stand, evident from aerial photos, was not sampled for age but does appear to be quite young. It is possible that one of the more recent ignitions severely burned this isolated patch creating the even-aged regeneration.

Summary

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Agee and Dunwiddie (1984) conclude that the tree invasion of historical grasslands on nearby Yellow Island may be the result of an altered micro-climate. They explain that higher than normal precipitation coincided with initial trends of tree invasion. Others (Peterson and Hammer 2001) attribute increased tree densities of historical savanna-like forests on neighboring Orcas Island primarily to fire exclusion.

We have demonstrated that the Iceberg Point and Point Colville study areas located on Lopez Island had a rather frequent-fire regime: 11.4 and 14.8 years, respectively. Regardless of the rationale for the invasion of coniferous trees and non-native vegetation into the historical grasslands within the ACECs of Lopez Island, it is probable that this fire dependent ecosystem has been influenced by fire's absence.

Paradoxically, unlike other areas where human interference has adversely affected natural landscapes, the undesirable circumstances under which these ecosystems currently exist are at least partially caused by the cessation of former human manipulation. The results of this study should provide rationale for management strategies regarding decisions that affect future restoration and maintenance of historical vegetative structures.

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Appendix

The following maps represent the confirmed fire-dates determined from the fire-scar samples acquired at Iceberg Point and Point Colville ACECs. A tree shape symbolizes the location of each sample and a red flame indicates the occurrence of a fire during the year identified on the map. A "susceptible sample" refers to whether the sample was alive with an open scar, therefore able to more easily record subsequent fires.

1615 Fire

Iceberg Point

1632 Fire

Iceberg Point

27

1656 Fire

Iceberg Point

Legend:
- BLM Administered Land
- Susceptible Sample
- Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

1699 Fire

Iceberg Point

Legend:
- BLM Administered Land
- Susceptible Sample
- Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

28

1725 Fire

Legend:
- BLM Administered Land
- ▲ Susceptible Sample
- 🔥 Sample Showing Fire

Bird

Light
Jen
95

24

100

100

23

236

Iceberg
140

25   25

Iceberg Point

0   500   1000 Feet

Contour Interval 20 Feet

N W E S

1740 Fire

Legend:
- BLM Administered Land
- ▲ Susceptible Sample
- 🔥 Sample Showing Fire

Bird

Light
Jen
95

24

100

100

23

236

Iceberg
140

25   25

Iceberg Point

0   500   1000 Feet

Contour Interval 20 Feet

N W E S

1752 Fire

Iceberg Point

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

1765 Fire

Iceberg Point

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

30

1779 Fire

Iceberg Point

1786 Fire

Iceberg Point

1798 Fire

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Iceberg Point

0   500   1000 Feet

Contour Interval 20 Feet

1804 Fire

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Iceberg Point

0   500   1000 Feet

Contour Interval 20 Feet

1818 Fire

Iceberg Point

1825 Fire

Iceberg Point

33

1869 Fire

Iceberg Point

Legend:
- BLM Administered Land
- Susceptible Sample
- Sample Showing Fire

0 500 1000 Feet

Contour Interval 20 Feet

1904 Fire

Iceberg Point

Legend:
- BLM Administered Land
- Susceptible Sample
- Sample Showing Fire

0 500 1000 Feet

Contour Interval 20 Feet

35

1914 Fire

Iceberg Point

Legend:
- BLM Administered Land
- ▲ Susceptible Sample
- 🔥 Sample Showing Fire

0 500 1000 Feet

Contour Interval 20 Feet

1941 Fire

Iceberg Point

Legend:
- BLM Administered Land
- ▲ Susceptible Sample
- 🔥 Sample Showing Fire

0 500 1000 Feet

Contour Interval 20 Feet

36

1613 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

25 ×

Sand

N
W   E
S

0   500   1000 Feet

Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

1628 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

25 ×

Sand

N
W   E
S

0   500   1000 Feet

Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

37

1640 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

Sand

25 ×

200

200

100

N
W E
S

0   500   1000 Feet
Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

1663 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

Sand

25 ×

200

200

100

N
W E
S

0   500   1000 Feet
Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

1702 Fire

Chadwick Hill ×470

Watmough Bay

Watmough Head

242 ×

BAY

RD

Sand

	BLM Administered Land
	Susceptible Sample
	Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

N W E S

Point Colville

1712 Fire

Chadwick Hill ×470

Watmough Bay

Watmough Head

242 ×

BAY

RD

Sand

	BLM Administered Land
	Susceptible Sample
	Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

N W E S

Point Colville

1725 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

25 ×

Sand

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

Point Colville

1737 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

25 ×

Sand

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

Point Colville

40

1750 Fire

Chadwick
Hill ×470

Watmough Bay

Watmough
Head

BAY

RD

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

Point Colville

1764 Fire

Chadwick
Hill ×470

Watmough Bay

Watmough
Head

BAY

RD

Sand

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

Point Colville

1768 Fire

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

1790 Fire

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

42

1817 Fire

Watmough Bay

Chadwick Hill ×470

BAY

RD

Watmough Head

242 ×

Sand

25 ×

N
W   E
S

0   500   1000   Feet

Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

1834 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

Sand

25 ×

N
W   E
S

0   500   1000   Feet

Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

43

1839 Fire

Chadwick Hill ×470

Watmough Bay

Watmough Head

BAY

RD

Sand

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

Point Colville

1850 Fire

Chadwick Hill ×470

Watmough Bay

Watmough Head

BAY

RD

Sand

BLM Administered Land
Susceptible Sample
Sample Showing Fire

0   500   1000 Feet

Contour Interval 20 Feet

Point Colville

1870 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

25 ×

Sand

N
W   E
S

0   500   1000 Feet

Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

1904 Fire

Chadwick Hill ×470

Watmough Bay

BAY

RD

Watmough Head

242 ×

25 ×

Sand

N
W   E
S

0   500   1000 Feet

Contour Interval 20 Feet

BLM Administered Land
Susceptible Sample
Sample Showing Fire

Point Colville

45

1916 Fire

Point Colville

BLM Administered Land
Susceptible Sample
Sample Showing Fire

1940 Fire

Point Colville

BLM Administered Land
Susceptible Sample
Sample Showing Fire